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Studying Nanoparticles Using Resonance-Enhanced Small-Angle X-ray Scattering in Thin-Film-Based Waveguides. Suresh Narayanan¹, Rodney S. Guico¹, Dong Ryeol Lee¹, Sunil K. Sinha², Jin Wang¹, ¹Experimental Facilities Div., Argonne National Laboratory, Argonne, IL 60439, ²Dept. of Physics, Univ. of California, La Jolla, CA 92093.

Metal nanoparticles dispersed in polymeric matrices can self-assemble to form complex nanocomposites, which is of great interest in the fabrication of novel electronic, magnetic and photonic devices. Since the entire ordering process takes place far from equilibrium conditions, a controlled self-assembly of nanostructures in two dimensions has to be guided by a thorough understanding of ordering kinetics and nanoparticle dynamics in the composites. This requires measurement of their lateral diffusion and transport in situ and in real time with subnanometer spatial resolution. Here, we report that a novel technique using resonance-enhanced small-angle x-ray scattering, which enhances the probing sensitivity by 2 orders of magnitude, can reveal in unprecedented detail such information regarding a system of dilute, yet disordered, gold nanoparticles embedded in an ultrathin polymer matrix. The motion of the nanoparticles is strongly anisotropic, with in-plane coalescence taking place more rapidly than out-of-plane diffusion, which facilitates the formation of two-dimensional structures.